

EXAMINED UTILITY MODEL PUBLICATION NO. 48-7051

TRANSPARENT SCREEN

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TRANSPARENT SCREEN

[Tohshi sukurihn]

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[There are no amendments.]

Specification

Title of the design

Transparent screen

Brief description of figures

Fig. 1 is a partial enlarged cross-section view showing the shape of the transparent screen cross-section of the present design, Fig. 2 is a graph that shows the relationship between transmittance T and diffusion angle θ of the transparent screen of the present design, and Fig. 3 is a graph that shows the results of measurement of the transparent screen of the present design.

Detailed description of the design

The present design pertains to an improvement of transparent screens capable of providing a wide-angle light diffusion property while good image-formation and a bright screen are retained, through arrangement of a fine particle non-reflective surface on one side of a diffusion sheet made of a thin plastic material with a light diffusion material uniformly mixed in it and forming a wave-like lenticular pattern on the other side.

The present design is explained in further detail with the drawings below. In Fig. 1, 1 is transparent screen produced by forming a fine particle non-reflective surface 3 on one side of a sheet-like diffusion layer 2 made of a thin plastic material with a light diffusion material, such as anhydrous magnesium silicate, uniformly mixed in it to form a light transmittance of approximately 60% and forming a lenticular surface 4 with lenses having identical radii of curvature that inflect at a specific interval on the other side in the direction perpendicular to the screen (horizontal direction in the fig.) to form a wave-like pattern.

In the screen having the above-mentioned structure, when one of lenticular lenses 4 is regarded as a convex lens, the angle of incidence of light that enters the spherical surface v_1 from the projector is β , the radius of curvature of the spherical surface of the lenticular surface 4 is r

and the pitch of the lenticular surface is P as shown in Fig. 1,

$$\sin \beta = P/2r$$

and the value obtained is defined as K . The angle formed by the exit beam of light having a height h for the v_1 surface of the lens and parallel to the optical axis and the optical axis is defined as θ and is used as the diffusion angle. In the same manner, when the diffusion angle for the angle of incidence for height $h + \Delta h$ is defined as θ' , $\Delta\theta = |\theta' - \theta|$ can be achieved, and furthermore, when the quantity of light at the angle of incidence of height h per unit height is defined as $I(h)$, the quantity of light of the exit beam per unit value is defined as $I'(\theta)$, and transmittance is defined as T , the relationship shown below can be established between the quantity of light entering through the interval Δh and the quantity of light exiting at an angle of $\Delta\theta$.

$$I(h) \cdot \Delta h \cdot T = I'(\theta) \cdot \Delta\theta$$

Therefore,

$$I'(\theta) = I(h) \cdot T \cdot (\Delta h / \Delta\theta) \dots\dots\dots (1)$$

Based on the relationship shown above, for example, when vinyl chloride is selected as a material for the diffusion layer, the relationship between the transmittance T and diffusion angle θ for K with a refractive index of 1.5 is shown in Fig. 2. In this case, the concave lens is the same as the convex lenticular surface when the radius of curvature of the spherical surface is r for the concave surface of the lenticular surface.

It is desirable when a bright and clear image is obtained at an angle of view of at least 15 to 20 degrees in the vertical direction and approximately 35 to 40 degrees in the horizontal direction of the projection screen, and in order to obtain an optimum screen within the above-mentioned practical angle of view, for example, in order to achieve diffusion angle θ of 37 degrees, $K=0.85$ is obtained from equation (1) or Fig. 2.

On the other hand, the beam of light that travels along the optical axis of the lenticular

surface advances directly inside the diffusion layer and is identified as a bright light by the viewer and projection performance is inhibited; thus, it is necessary to establish the pitch of the lenticular surface at an appropriate degree. In general, the visual limit of distinguishing two lines accurately is 20", thus, when the distance between the screen and the viewer is L m/m, $P = L \times 0.000097$ (rad) = approx. $L \times 10^{-4}$. Therefore, in order to achieve an optimum screen at an angle of view of 37 degrees and distance between the screen and viewer of 2 m, a lenticular pitch of $P=0.2$ mm and radius of curvature of $r=0.12$ mm are suitable.

[p. 2]

Fig. 3 is a graph where a vertical incident beam of light is applied to the screen, and the angle of the transmitted light in the same direction as the incident light is defined 0 degrees and the angle of light on a flat surface that includes transmitted light of angle 0° is changed from 0° to 50° and the quantity of light at each angle is measured and the quantity of light at 0° angle is shown as 100; curve A shows the characteristic in the horizontal direction of the screen and curve C shows characteristic in the vertical direction of the screen.

According to the present design, a significant increase in the diffusion property in the horizontal direction of the screen is possible based on the specific shape of the lenticular surface, and a narrow angle of view is required in the vertical direction; thus, the mixing ratio of the diffusion material can be reduced, and the thickness of the diffusion layer can be reduced, and a transparent screen having excellent light transmittance and good image-formation properties with an absence of nonuniform colors can be produced.

Claim of the design

A transparent screen produced by forming a wave-like pattern having identical radii of curvature on one or both surfaces of a sheet-like diffusion layer made of a thin plastic material with a fine diffusion material uniformly mixed in so as to form light transmittance of

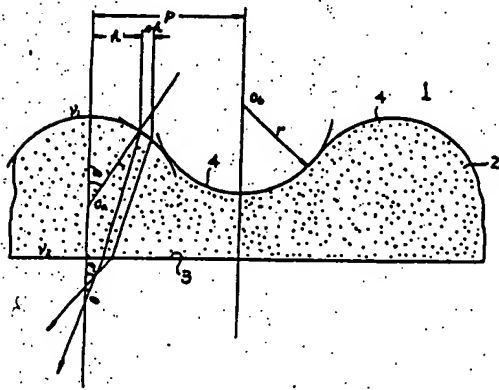
approximately 60%, and a non-reflective surface of fine particles is formed on the other surface and having a lenticular wave-like pattern of $K = 0.3$ to 0.9 and $P \text{ approx.} = L \times 10^{-4}$ when the ratio of the pitch of the aforementioned lenticular surface P (mm) and the radius of curvature r (mm) is $p/2r=K$ and the distance between the screen and viewer is L (mm).

References cited

JP Sho 28-1528 (J, U)

British Patent No. 969071

Fig. 1



[p. 3]

Fig. 2

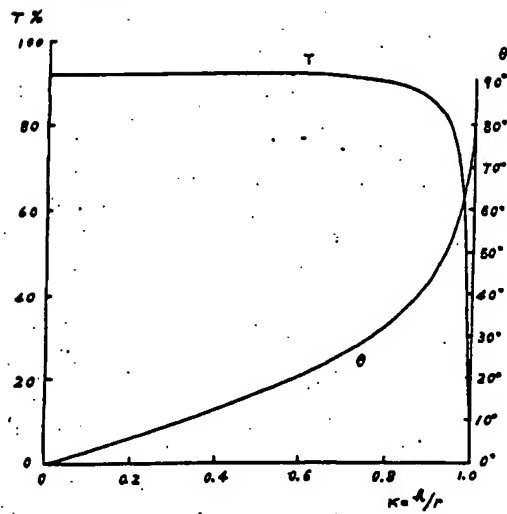
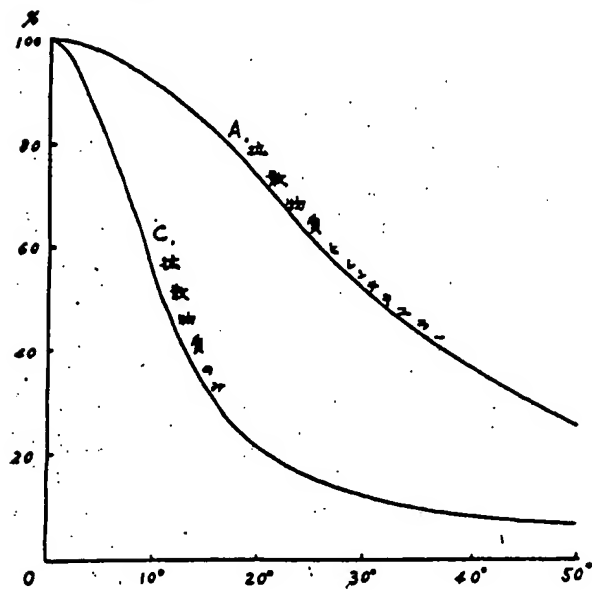


Fig. 3



Vertical axis: diffusion quantity of light

Horizontal axis: Angle

A: Diffusion material and lenticular surface

B: Diffusion material alone

昭48-7051

実用新案公報

⑫ 公告 昭和48年(1973)2月23日

(全3頁)

1

⑭ 透視スクリーン

⑰ 実 願 昭43-109037

⑱ 出 願 昭43(1968)12月16日

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図面の簡単な説明

第1図は、本案による透視スクリーンの断面形状を示す部分拡大断面図、第2図は、~~本案~~透視スクリーンの透過率 T 及び拡散角 θ の関係を示すグラフ、第3図は本案スクリーンの測定結果を表わすグラフである。

考案の詳細な説明

本案は、光拡散物質を均一に混入した薄い可塑性材料より成る拡散層のシートの一面に微粒子状の無反射面を、他面にはレンチキュラーを凹凸に波形状に形成することにより、良好な結像性能と明るい画面を保持したまま、広角度の光拡散特性を得ることのできる透視スクリーンの改良に関するものである。

以下図面に従って本案を説明すると、第1図において、1は、例えば無水珪酸マグネシウム等の光拡散物質を光透過率が約60%となるように均一に混入した可塑性材料より成るシート状の拡散層2に、その一面には微粒子状の無反射面3を、他面には一定間隔で反曲する同一曲率半径のレンチキュラー4を波形状にスクリーンの上下方向(図の左右)に形成した透視スクリーンである。

かかる構成のスクリーンにおいて、第1図に示すように、レンチキュラー4の一つを凸レンズと考え、映写機から球面 ν_1 へ入る光の入射角を β 、レンチキュラー4の球面の曲率半径を r 、レンチキュラー4のピッチを P とすると、

$$\sin \beta = \frac{P}{2r}$$

2

この値を K とする。レンズの ν_1 面に対して高さ h の、光軸に平行な光線の射出光線と、光軸とのなす角を θ とし、これを拡散角とする。同様に、高さ $h + \Delta h$ の入射光に対する拡散角を θ' とすれば、 $\Delta \theta = \theta' - \theta$ となり、又、高さ h の入射光の単位高さ当りの光量を $I(h)$ 、射出光線の単位角度当りの光量を $I(\theta)$ とし、透過率を T とすれば、幅 Δh に入射する光量と角度 $\Delta \theta$ で射出する光量との間には次の関係が成立する。

$$I(h) \cdot \Delta h \cdot T = I(\theta) \cdot \Delta \theta$$

従つて、

$$I(\theta) = I(h) \cdot T \cdot \frac{\Delta h}{\Delta \theta} \dots\dots\dots (1)$$

これらの関係から、拡散層の材料として例えば塩化ビニールを選んだ場合、その屈折率を1.5として K に対する透過率 T 及び拡散角 θ の関係を求めたものが第2図である。この場合、レンチキュラーの凹面についても、第1図において球面の曲率半径 r を負として凹レンズを考えれば凸面のレンチキュラーと同様に考えることができる。

映写スクリーンは、少なくともその上下方向においては $15^\circ \sim 20^\circ$ 、又、左右方向においては $35^\circ \sim 40^\circ$ 程度の視角範囲内において鮮明で明るい像が得られることが望ましいので、この実用的視角範囲内において最適のスクリーンを得るため、例えば、拡散角 θ を 3° とするには、(1)式の関係或いは第2図より $K = 0.85$ を得る。

一方、レンチキュラーの光軸に沿つて進む光線は、拡散層内を直進し、観視者に輝線として識別され、映写効果を害するので、レンチキュラーのピッチ P を適当に定める必要がある。一般に眼の二線識別精度は $20''$ とされているので、スクリーンと観視者の間の距離を L m/mとすれば、 $P = L \times 0.000097$ (rad) $\div L \times 10^{-4}$ となる。これらのことから、例えば、視角範囲 3° 、スクリーンと観視者の間の距離2 mにおいて最適のスクリーンを得るには、レンチキュラーのピッチ $P = 0.2$ mm、曲率半径 $r = 0.12$ mmとすればよいことがわかる。

3

4

第3図は、このスクリーンに垂直な入射光を当て、入射光と同一方向に透過する透過光の角度を 0° とし、角度 0° の透過光を含む平面上で光線の角度を 0° から 50° まで変化させ、各々の角度における光量を測定したもので、角度 0° のときの光量を100として表わしたグラフであり、曲線Aはスクリーンの左右方向の特性を、曲線Cは上下方向の特性を示している。

本案によれば、スクリーンの左右方向の拡散性能がレンチキュラーの特定の形状設定により大きく高められ、上下方向に関しては、實際上狭い視角範囲しか要求されないため、拡散物質の混入量を少なくでき、拡散層を薄くすることができ、実用上十分な視角範囲内で透光性、結像性が良く、色調にむらのない透視スクリーンを得ることができる。

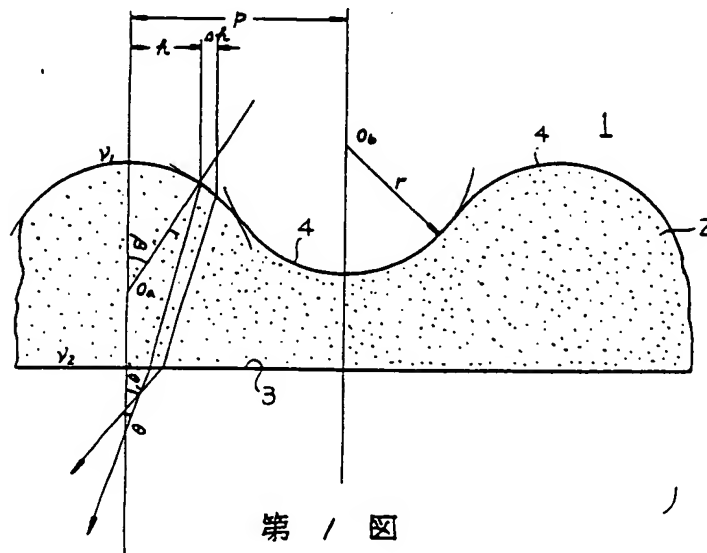
⑤実用新案登録請求の範囲

微細な拡散物質を透過率が60%以上となるように均一に混入した可塑性材料より成るシート状の拡散層の一面又は両面に互いに接する、同一曲率半径の凹凸のレンチキュラー波状面を形成し、他面に微粒子の無反射面を設け、前記レンチキュラーのピッチ P (mm)と曲率半径 r (mm)の比を $p/2r=K$ 、スクリーンと観視者の間の距離を L (mm)とすると、 $K=0.3\sim0.9$ 、 $P=L\times 10^{-4}$ によつて定められる前記レンチキュラー波状面を有する透視スクリーン。

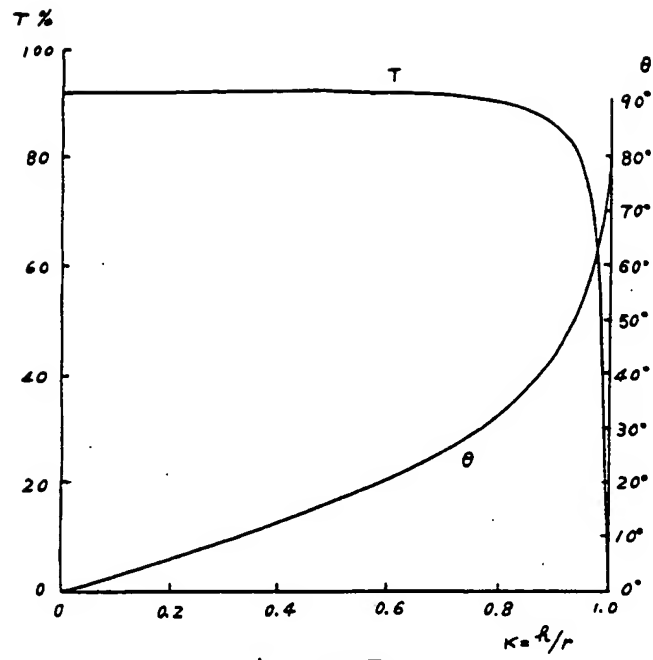
⑥引用文献

15 実 公 昭28-1528

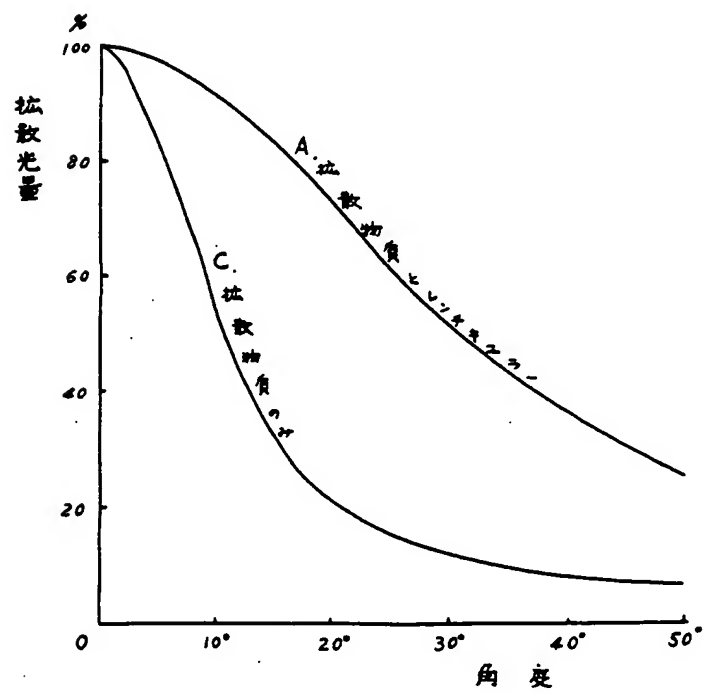
英国特許 969071



第 1 図



第 2 図



第 3 図

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